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Monitoring of Pesticide Residues in Commonly Used Fruits and Vegetables in Bengaluru

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Abstract

Gas chromatography-mass spectrometry (GC-MS) and Liquid chromatography mass spectrometry (LC-MS) were used to evaluate the level of different pesticides in some commonly used fruits in Bengaluru region of Karnataka. Although most fruits and vegetable samples analyzed were found to be contaminated with pesticide residues, they were under maximum residue limit (MRL) after the salted water wash. Samples with residues above MRL may pose health hazards to the consumers. It may be due to lack of awareness of the farmers about the application dose, method of application and withholding period. The findings of this study provide important data about contamination of pesticide residue in some fruits and vegetables sold in Bengaluru.

Keywords: Pesticide residues, Market Survey, Fruit Samples and Maximum residue limits

1. Introduction

Pesticides are chemical substances used to kill insects and animals that destroy crops. They are widely used in fruit and vegetables because of their susceptibility to insect and diseases. Pesticides

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have been applied in agriculture and animal production to eliminate pests. Application of pesticides in modern agriculture has boosted farm productivity. In this way, to increase both animals and crops outputs, improve quality of products and decrease the incidence of illnesses propagated by insects.[1] The use of pesticides has resulted an increase in agricultural production worldwide but some persistent pesticide residues have great potential adverse impact on the environment and human health. They improve the quality and extend the storage life of food crops, but are very hazardous and lethal for organisms as well as for humans.[2] They are danger to consumers, bystanders and workers during manufacture and transport. Vegetables and fruits are commonly used everywhere to meet the requirement of balance diet and good health. Pesticides decrease the biodiversity in soil and it has been found that the quality of soil is higher in the absence of pesticides with the additional effect of higher water retention. They are characterized by pronounced persistence against chemical/biological degradation, high environmental mobility, strong tendency for bioaccumulation in human and animal tissues, and significant impacts on human health and the environment, even at extremely low concentrations.[3]

The behavior of pesticides in agriculture is of great importance. The disappearance, persistence, or partial transformations of these compounds determine its usefulness or its potential effects to our environment.[4, 5] The majority of the pesticides are applied directly to the soil or sprayed over crop fields and hence released directly to the environment. [6] In fruits and vegetables production, insecticides are used to control pests and fungicides to control diseases. They are directly applied to the crops and some may still be present as residues in the fruits and vegetables after their harvest. It is true that that most insecticides and fungicides are toxic substances, but when used properly they constitute an important input in fruits and vegetable production in order to produce economically marketable products. However improper usage has occasionally been accompanied by hazards to man and the environment.[7] The applied chemicals and their degradation products may remain as residues in the agricultural products, which becomes a concern for human exposure. Children have been found to be especially susceptible to the harmful effects of pesticide exposure. The major source of pesticide exposure in children and infants is through diet. Early exposure results in brain cancer, leukemia and birth defects. However children who have adopted an organic diet are less exposed to the harmful effect of organophosphorous pesticides.[8]

Residue analysis provides a measure of the nature and level of any chemical contamination within the environment and of its persistence. The most common pathway for pesticides to enter the body is orally, through the mouth and the digestive system, dermally through skin or by inhalation through the nose and respiratory system. As pesticides are hazardous and toxic to human health any pesticide residue remaining in fruits and vegetables can pose danger to humans and cause certain diseases.[9] It is important to identify and quantify the pesticides which are present in fruits and vegetables after pesticide spray. Residues of most pesticides are present in all compartments of agro-ecosystems, but perhaps the most real risk of human is through consumption of residues in food as vegetables and fruits.[10] Some of these pesticides in particular are persistent and very resistant to microbial degradation. The high toxicity of most pesticides has made their use very restrictive and currently forbidden in most developed countries since 1970s.[11]

General population is mainly exposed to organophosphorous pesticide (OPPs) residues through the ingestion of contaminated foods (such as cereals, vegetables, and fruits), which are directly treated with OPPs pesticides or are grown in contaminated fields. Compared with Organo chlorine pesticides, OPPs demonstrate relatively low environmental persistence but a higher toxicity acute. [12] In this paper we analyzed the pesticide residues in few fruits and vegetables collected from in and around Bengaluru. This study can provide useful information for authorities to regulate pesticide residues in fruits and to protect consumer health.

2. Materials and Methods

For the present study random sampling was done from the various markets in Bengaluru and Chikkabellapur. All chemicals are purchased from Merck and used without further purification.

2.1 Sample preparation

Different samples of fruits including apple, orange, grapes and guava were collected during the period of December – March. Depending upon the nature of the vegetation (size, shape, etc.), samples were enclosed in a clean blotting paper and wrapped inside a clean paper envelope. It is then placed in plastic bags and then brought to the laboratory and put in refrigerator at 5 °C to be used later for extraction step. The addition of a small sachet of silica gel to the envelope helps to reduce the moisture content of the system.

Analytical grade chemicals were used for the extraction. 20 g of each fruit sample was taken and 20 mL of distilled water was added. The mixture was left to stand for 15 minutes, to which 50 ml of acetonitrile was added and the sample was homogenized by crushing in a pistil and mortar. The sample was filtered by suction. The process is repeated and the total volume was increased to 100 mL by addition of acetonitrile. From this solution 20 mL of sample was taken to which 10 g of NaCl and 20 mL of 0.5 mL/L of phosphate buffer (pH 7.0) was added and shaken. The solution was left to stand and removed the aqueous layer. The organic layer was dried over anhydrous sodium sulphate and filtered.[13] This sample was tested for pesticide residue by LC-MS and GC-MS analysis. Pesticide standard solutions were prepared in acetonitrile.

3. Results and Discussion

Different fruits and vegetables were tested for pesticide residue levels under different conditions like without wash, with water wash and with salted water wash. Table 1 shows the common names and scientific names of fruits and vegetables under study.

Fruits		Vegetables	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Grape	*Vitis vinifera*	Brinjal	*Solanum melongena*
Apple	*Malus domestica*	Cauliflower	*Brassica oleracea*
Orange	*Citrus sinensis*	Tomato	*Solanum lycopersicum*
Guava	*Psidium guajava*		

Table 1: Common name and Scientific name of the fruits and vegetables under study

3.1 Fruits

Table 2 shows the pesticide names, chemical active group, usage, molecular weight, retention times and selected MS main ions (m/z) of some common pesticides and Table 3 shows the Maximum residue limits (MRLs) of common pesticides present in grapes, apples and oranges as per Indian standards.

3.1.1 Grapes

Black and green grapes were selected for the analysis under different conditions. Grapes analyzed without washing from

Pesticide	Group	MW- (g/mol)	t_R (min)	MS - Selected ions (m/z)
Dichlorvos	OP	221	4.29	109, 145, 185
Dimethoate	OP	229	6.82	87, 125
Chlorpyrifos Methyl	OP	322	7.65	208, 288, 286
Disulfoton	OP	274	7.30	109, 157
Malathion	OP	330	8.24	127, 158, 173
Chlorpyrifos	OP	349	8.41	197, 199, 258, 314
Endosulfan sulfate	OC	422	11.01	272, 387, 420
DDT	OC	354	11.00	165, 235, 237
Parathion	OP	291	8.39	125, 291

Table 2: Common pesticides and their properties

	Grape	Apple	Orange
Dichlorvos	100	100	100
Dimethoate	2000	2000	5000
Chlorpyrifos Methyl	200	500	500
Disulfoton	500	500	500
Malathion	20	20	20
Chlorpyrifos	500	1000	1000
Endosulfan sulfate	2000	2000	2000
DDT	1000	1000	1000
Parathion	500	500	500

Table 3: Common pesticides and their Maximum Residue Limits

different markets show the presence of Thiabendazole, Carbendazin and Chlorpyrifos residue. Black grapes had higher residue value than green grapes. After washing with water also these residues were present but showed a decrease. Salted water wash showed a high decrease in the residue level, but Thiabendazole was above Maximum residue limit (MRL). Black grapes showed much higher residual values in all the three types of analysis. The results are presented in Figure 1 (a) and (b). Group OP is Organophosphage and group OC is Organochlorine.

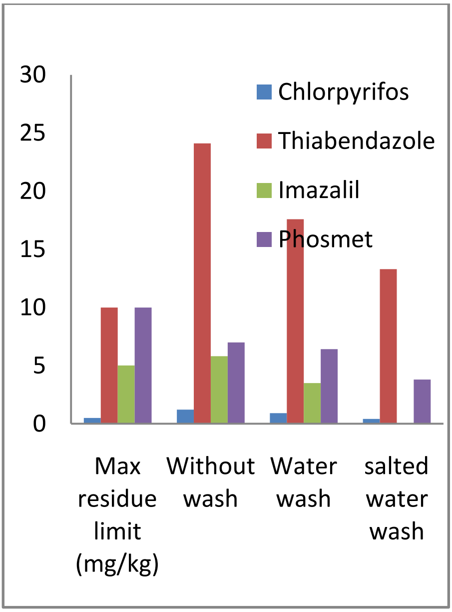

Figure 1 (a): Pesticide residues found in green grapes

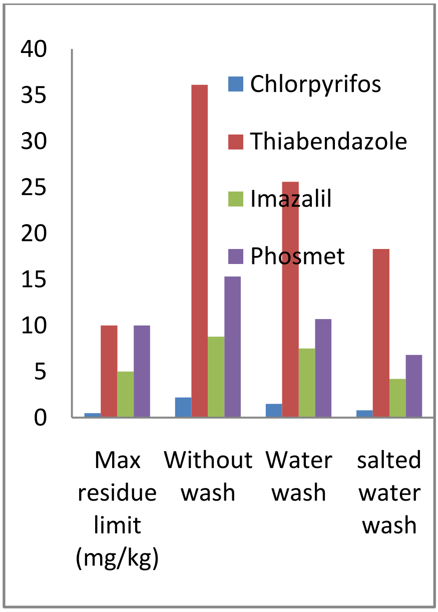

Figure 1 (b): Pesticide residues found in black grapes

3.1.2 Apples

Pesticides like Diphenylamine, Chlorpyrifos, Thiabendazole and Malathion were found to be extremely persistent when tested without wash on apple samples. Water wash removed diphenyl

amine while others were still present. After salt water wash, Thiabendazole and Malathion were still present. The results are given in Figure 2. All these insecticides were registered under section 9 (3) of the Insecticide Act, 1968. MRL of each pesticide is different for different fruits.

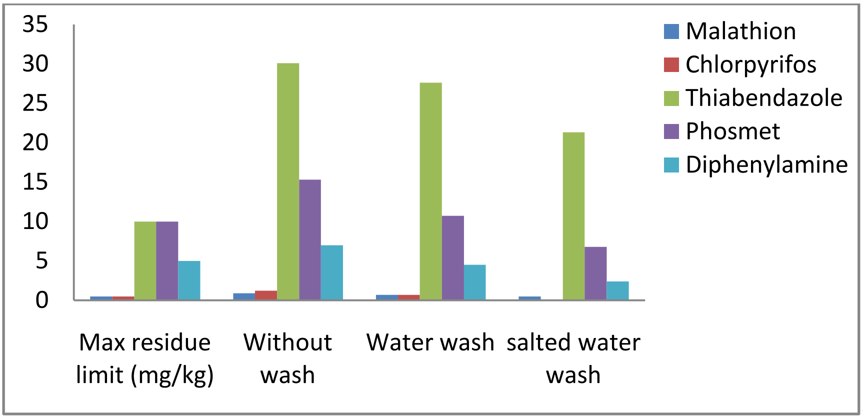

Figure 2: Pesticide residues found in Apple

3.1.3 Oranges

All the samples were showing the presence of pesticide residues of Chlorpyrifos, Thiabendazole, Endosulfan sulfate and fungicide residues of Imazalil, Disulfoton, without wash. After washing the residue level decreased but Thiabendazole, Endosulfan sulfate were higher than that of MRL. Results are given in Figure 3.

3.1.4 Guava

Before water wash all the pesticide residues on guava were well under the prescribed level. After the salted water wash all the residue went down to non-detectable level.

3.2 Vegetables

Different vegetables were tested for pesticide residue levels under different conditions like without wash, with water wash salt and with salted water wash.

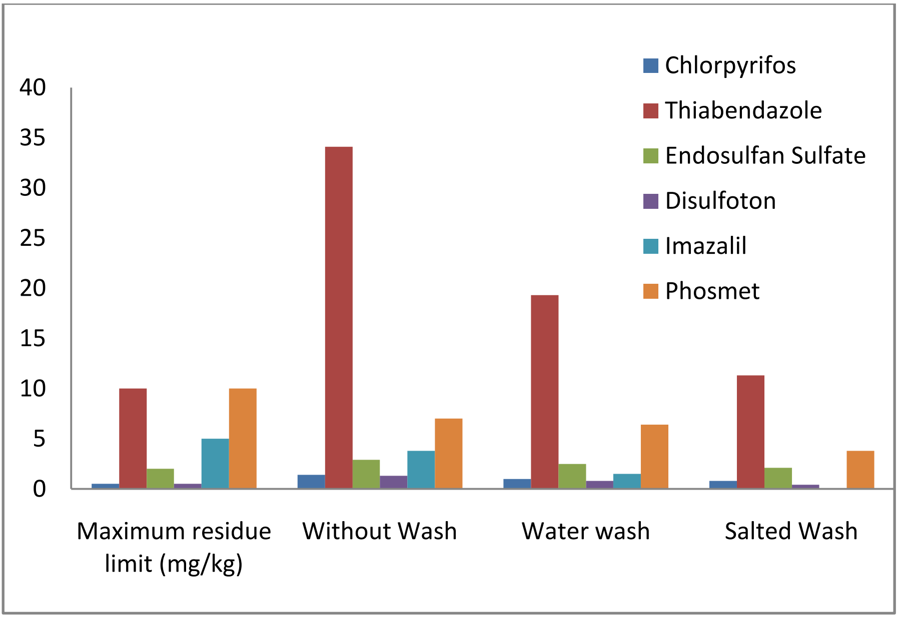

Figure 3 Pesticide residues found in Orange

3.2.1 Brinjal

Chlorpyrifos, Thiabendazole, Acephate residues were very high in the samples without wash, while the amount is decreased considerably after salted water wash. The results are tabulated in Table 4. More washing will be required to decrease the residue levels.

Pesticide	MRL (mg/kg)	Without Wash	Water wash	Salted water wash
Diphenylamine	5	8.8	4.3	3.4
Chlorpyrifos	0.5	1.4	1	0.8
Thiabendazole	10	34.1	19.3	10.3
Endosulfan	2	2.2	1.5	1.1
Acephate	2	4.2	3.2	2.6
Imazalil	5	3.8	1.5	Nil
Phosmet	10	7	6.4	3.8

Table 4 Pesticide residues detected in Indian Egg Plant or brinjal

3.2.2 Tomato

The pesticides detected in tomato without wash were Chlorpyrifos, Malathion, Cypermethrin and Endosulfan, but their amount was under MRL (Table 5). After water wash and salted water wash, all were not detected.

Pesticide	MRL (mg/kg)	Without Wash	Water wash	Salted water wash
Chlorpyrifos	0.5	0.4	0.2	Not detected
Malathion	20	19	10	5.8
Cypermethrin	0.5	0.4	0.1	Not detected
Endosulfan	2	1.9	0.8	Not detected

Table 5: Pesticide residues found in Tomato

3.2.3 Cauliflower

Without wash Chlorpyrifos, Malathion, Cypermethrin were present in the samples, even after water wash also the residue were present but in less amount. Salted water wash had decreased the pesticide content to much lower value.

Pesticide	MRL (mg/kg)	Without Wash	Water wash	Salted water wash
Chlorpyrifos	0.5	1.4	0.9	0.5
Malathion	20	28	19	15
Cypermethrin	0.5	0.4	.1	Not detected
Endosulfan	2	Not detected	Not detected	Not detected

Table 6 Pesticide residues in Cauliflower

The pesticide contents in vegetables were found to be less or under MRL in most of the cases. It can be because of the time delay between the spraying day and the consumption day. It is better to consume the vegetables after 3 to 7 days of spraying the pesticides. Iqbal and co-workers had reported that brinjal fruit is suitable for consumption of public after 3 days of spraying without posing any hazard to human health as MRLs adopted by Central Committee for Food Standards (CCFS) under the Ministry of Health & Family Welfare India. The pesticide residue was found to decrease [15].

The information gathered through the field survey indicated that most of the growers were illiterate. Majority of the farmers interviewed indicated that they did not observe the withholding periods. They spray the field in the afternoon and pick the vegetables early in the morning for selling in the local market. Most of the growers, vegetable growers and fruit growers were found unaware about the recommended doses, spray intervals and the harmful effects of these chemicals on human health. It was found that only few farmers attended courses on the safe use of pesticides and application techniques while the rest of the respondents had not got any such training. Majority of vegetable and fruit growers consult pesticide dealers for recommendation of pesticide and were not using protective clothing during the spraying. Only few fruit growers were found spraying on the recommendations of agriculture experts.

In view of the above findings, it may be concluded that the level of contamination found in the fruit and vegetables collected from fields of farmers could be linked to improper farmer practices as noted during the discussion with the farmers. Due to illiteracy of the farmers and lack of effective legislation in the country, picking of vegetables and fruits without taking into account their withholding period may lead to residues higher than the tolerance limits. The results of our study support the view that pesticides are used excessively by some local farmers.

The outcomes of the present study authenticate the existence of pesticides such as chlorpyrifos, dieldrin, endosulfan sulfate, parathion, disulfoton and triadimefon in fruit samples which were applied in pre-harvest treatment. Frequent occurrence of pesticide residues in fruits and vegetables may be due to the lack of awareness of the growers about the dosage, right ways of application and the suitable interval between harvesting and pesticide treatment. The carelessness or non-availability of correct guidance concerning the pesticide application may be another reason for pesticide residues in the fruit samples. These contaminated fruits are potential health risks to the consumers. To avoid adverse effects on public health it is a necessity to set up control measures so as to make sure that each pesticide should be below MRLs in the fruits to be marketed. The study has presented significant information regarding pesticide residue contamination on fruits. On the bases of achieved results, it is recommended that regular evaluation of pesticide residue should be carried out on each fruit for the planning and future policy about the formulation of standards and quality control of pesticides. The improper use of pesticides shows the way to terrific financial losses and dangers to human health.

4. Conclusion

From the results obtained, it can be concluded that most of the fruit and vegetable samples analyzed were contain residues of pesticides, but most of them were under MRL after the salted water wash. This study discloses that even low exposure to these pesticide residues puts consumer on risk in a cumulative manner. The amounts of pesticides remained as residues in food are miniscule sometimes only 1 millionth of a kilogram. The official safety limits allowed in our daily intake are also incredibly small. We cannot say for sure that there is ever a “safe” level of pesticide residues in food. So an analysis showing the residues in undetectable or safe range does not essentially mean that it is absolutely safe and free of any untoward effects. On the basis of the above findings, the results recommend the need for stringent standards to govern the application of pesticides in the field to ensure that pesticides are applied only when necessary and in a safer manner. It may also be concluded that periodical monitoring of fruits and vegetables for pesticide residues is essential to assess their contamination status and accordingly farming community be imparted training on the judicious use of pesticides and create awareness on the health hazards involved in pesticide misuse.

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